Astrobiology Technology Branch Overview

The Astrobiology Technology Branch supports the development of advanced technologies in astrobiology as they relate to the exploration of space and understanding life in the universe. Current branch efforts encompass research and technology development for advanced life support, utilization of planetary resources, astrobiology advanced missions, and technology transfer to benefit life on Earth. Advanced Life Support focused research is directed primarily at physicochemical processes for use in regenerative life support systems required for future human missions and includes atmosphere revitalization, water recovery, waste processing/ resource recovery, and systems modeling, analysis and controls associated with integrated subsystems operation. *In Situ* Resource Utilization (ISRU) technologies will become increasingly important on every Mars lander between 2001 and a human mission to Mars. The branch focus is on the development of technologies for Mars atmosphere acquisition, buffer gas production, and CO_2 compression. Research and technology development for astrobiology advanced missions includes the development of technologies for hydrothermal vent "missions," piggyback Europa penetrators, artificial ecosystems, and systems for planetary ecology detection. The Multiple Sclerosis Technology Transfer program is a spin-off application of astronaut cooling garments, with research focused on utilization of this technology by heat sensitive Multiple Sclerosis patients to alleviate symptoms and improve quality of life. Researchers in the branch also develop flight experiments and associated hardware for shuttle, ISS, and unmanned NASA missions.

M. Kliss, Chief SSR

Advanced Life Support Research and Technology Development

Mark Kliss

The research and development of advanced life support technologies at Ames Research Center will help enable long duration missions and the human exploration and development of space. The major objectives of advanced life support research is to: 1) reduce life support system life cycle costs, 2) improve operational performance, 3) promote self-sufficiency, and 4) minimize expenditure of resources during long duration human missions. The main focus of the research at Ames in 1998 was on waste processing and resource recovery, modeling and analysis, and In Situ Resource Utilization (ISRU).

Waste processing systems that eliminate noxious wastes are a necessary component of any fully regenerative life support system that incorporates food production. Waste processing can be accomplished by either biological or physical-chemical systems. The optimum method of processing is dependent on the ability of food production systems and humans to reutilize the reclaimed materials. A thorough understanding of the impurities in the reclaimed materials and the effect of these impurities on plants and humans is required in the development of waste processing systems. The research effort was focused on integrating a prototype incinerator, developed by Ames Research Center, with a catalytic test stand in order to evaluate newly developed catalyst systems. Of primary interest was the use of an advanced catalyst to remove nitrogen dioxide and nitric oxide from the incinerator flue gas by reducing them with carbon monoxide to form nitrogen and oxygen. This approach is extremely promising because it requires no additional chemicals, such as ammonia, for the reduction process. Using carbon monoxide at concentrations of several thousand parts per million, it was demonstrated that nitrogen oxides can be reduced in incinerator flue gas from concentrations of 50 parts per million to less than 1 part per million.

For the modeling and analysis research effort at Ames, data from existing literature, universities, and other NASA Centers was utilized to develop individual crop models for the candidate crops that might be incorporated into the 'BIO-Plex' human-rated advanced life support test chamber at Johnson Space Center. The models accounted for carbon dioxide uptake, oxygen production, edible and inedible biomass production, water vapor production, and water uptake from the nutrient solution as functions of the carbon dioxide concentration, light level, and crop growth area. The models were then used to evaluate system management and operations issues and to conduct system trade studies. It was shown in a comparison of separate (multiple) and single air loop configurations that as long as food production rates are greater than 50% of crew requirements, the existing air revitalization system can be eliminated and a single loop air revitalization system linking the crew chambers, food production chambers and waste processing systems can adequately control the carbon dioxide level by varying the solid waste processing rate. Scientific analyses of soil and rock samples on Mars will require the use of carrier gases such as nitrogen and argon for moving analytes and purging instrumentation. The ISRU research efforts at Ames relating to the 'mining' of Mars' atmosphere, culminated in the development of demonstration hardware which is capable of separating and purifying a nitrogen-argon carrier gas mixture away from the martian atmosphere and compressing the mixture to a usable pressure. Both the separation and compression processes were performed via adsorption. In addition to being low-mass, low-volume, and virtually solid state, the process consumes virtually no electrical power since the energy to perform work is taken entirely from the Mars diurnal temperature cycle. Figure 19 shows a concept drawing of such a device. It weighs less than 100 grams, occupies a volume roughly equal to a 12-ounce soda can, and produces enough carrier gas for several analyses a week for an indefinite period of time. This technology is applicable to all lander and rover missions to Mars and has other possible uses both within NASA, by providing compressed carbon dioxide for generating buffer gases for life support, and in the private sector, by producing purified compressed gases in remote locations or in applications having stringent restrictions on power, noise, or vibration. ❑

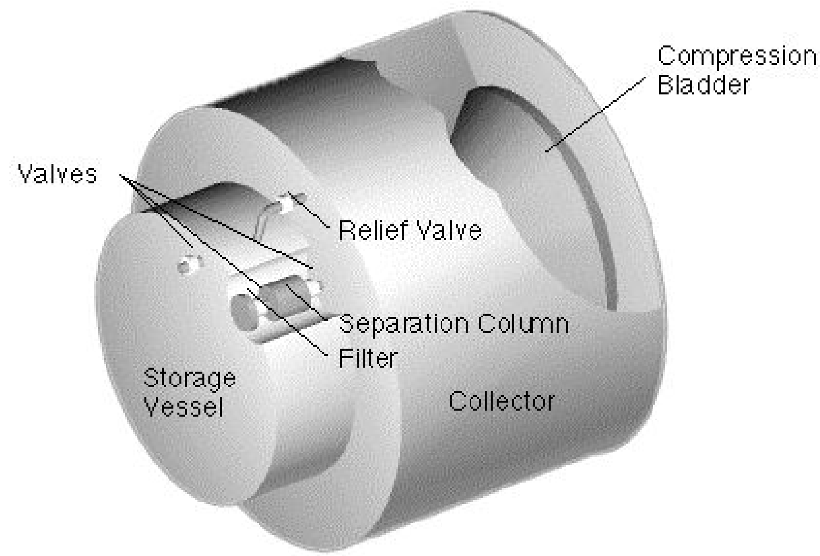

Figure 19. A concept drawing of ISRU hardware which can extract and compress carrier gases from the martian atmosphere.

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